

# Introduction

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Study of the ectoparasites of vertebrates has been greatly intensified since World War II, chiefly because of an increased interest in zoonoses, diseases of animals communicable to man. Particular emphasis has been placed on the underdeveloped areas of the world, including large parts of tropical America, whose ectoparasite fauna is still poorly known. The experience of medical entomologists has shown that taxonomic and ecological studies of animal reservoirs and vectors are essential to investigating the epidemiology of arthropod-borne diseases and must precede any organized effort to control them. The importance of ectoparasites in the epidemiology of such diseases is aptly illustrated by the role of fleas in the transmission of plague, of trombiculid mites in scrub typhus, of ticks in Rocky Mountain spotted fever.

The attention of medical entomologists was first focused on Panama by the classical work with yellow fever and malaria during the building of the Canal. Through the control of these and other diseases, a safe and sanitary environment was rapidly established in the Canal Zone, and shortly thereafter in Panama. This enabled trained personnel to reside in the area for long periods of time and to conduct extended field and laboratory investigations of other arthropod-borne diseases and of the natural history and resources of Panama.

The providing of adequate facilities and of an atmosphere congenial to research at the Board of Health Laboratory at Ancón, under the leadership of research-minded Samuel Taylor Darling, directed the interest of several persons toward medical entomology. Notable among them was Lawrence H. Dunn, who produced the first work of any consequence on the ectoparasites of Panama (1916, et seq.).

The initiation of biological surveys of the Canal Zone under the auspices of the Smithsonian Institution further stimulated interest in the

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area and led to the publication of Goldman's *Mammals of Panama* in 1910 and Standley's *Flora of the Panama Canal Zone* in 1928. In this period, too, the volumes by Meek and Hildebrand on the fishes of Panama, both fresh water and marine, were published by the Field Museum (now the Chicago Natural History Museum). In 1924, the opening of the field laboratory on Barro Colorado Island provided much-needed facilities for work in the area. Many of the scientists who worked on the island collected ectoparasites.

In 1929, the Gorgas Memorial Laboratory was established as a research institute for tropical medicine. From its beginning, it was a center for studies in medical entomology; staff members published papers on ectoparasites and furnished material for specialists elsewhere. In 1943, Fairchild listed most of the then-known ectoparasites of Panama (excluding the Mallophaga and the pupiparous Diptera), a total of 63 species and subspecies belonging to 21 genera. He also gave a partial bibliography of relevant publications.

In 1956, a systematic survey of the ectoparasite fauna of Panama was initiated by Major (now Lt. Colonel) Robert M. Altman. By 1959 a considerable backlog of information and unworked material relating to Panamanian ectoparasites had accumulated, both in Panama and in various collections elsewhere. The fortuitous circumstances which brought together Drs. Conrad E. Yunker and James M. Brennan at the Middle America Research Unit, Major Vernon J. Tipton with the Army Environmental Health Branch, and Dr. Phyllis T. Johnson, Mr. Eustorgio Méndez, and Dr. Graham B. Fairchild at the Gorgas Memorial Laboratory, all interested in ectoparasites, proved mutually stimulating. These workers continued the project begun by Major Altman.

Field work by Dr. Alexander Wetmore on the birds of Panama and by Dr. Charles O. Handley on the mammals, together with field investigations of arthropod-borne virus diseases that were being carried out by Mr. Pedro Galindo of the Gorgas Memorial Laboratory, offered unrivaled opportunities to make extensive collections in remote areas that would have otherwise been difficult to reach. Thus, the ectoparasites of Panama have been more thoroughly collected than those of any other area of comparable size in tropical America.

In the course of this survey, over 360 species of blood-sucking ectoparasites, representing more than 120 genera were collected. Of these, 15 genera and more than 115 species were new. As a consequence it became necessary to enlist the aid of other specialists to study and report on the material collected.

Because of the difficulties encountered in identifying the numerous species in diverse groups and the widely scattered literature on the subject, Major Vernon J. Tipton and Dr. Rupert L. Wenzel suggested the desirability of bringing together the papers resulting from these studies and, thus, to incorporate in one volume most of what is known about the ectoparasites of a single area. It seemed particularly appropriate that this should be done for Panama because of its significance in the history of medical entomology. The enthusiastic cooperation of the participating

specialists, the officials of the Chicago Natural History Museum, and the United States Army (Medical Research and Development Command, Office of the Surgeon General) made this possible.

The fauna of Panama is of special interest, because the isthmian region is the only dry-land bridge between North and South America. Knowledge of the present Panama fauna is of great importance in understanding the movements and distribution of the animals of both continents. Furthermore, the relatively small land area, with its great diversity of habitats and climatic zones, contains an unusually rich fauna of manageable size. It is believed, therefore, that the following papers, although primarily taxonomic in purpose, will prove of basic usefulness not only to those engaged in studies of zoonoses in this area, but also those with broader zoological interests.

The Republic of Panama occupies the isthmus between North and South America. It is a roughly S-shaped area with its long axis running approximately east and west. It lies between  $7^{\circ} 09'$  and  $9^{\circ} 37'$  North latitude, and  $77^{\circ} 09'$  and  $85^{\circ} 01'$  West longitude, hence wholly within the tropics and about 1200 miles directly south of Miami, Florida. It is bounded on the west by the Republic of Costa Rica, on the north by the Caribbean sea, on the east by the Republic of Colombia, and on the south by the Pacific Ocean. It has a maximum east-west extension of about 475 miles, and a north-south extension of about 225 miles, but because of its shape no straight east-west line passes wholly over land and no point within the country is much more than 30 miles from salt water. The exact area is not known; published figures vary from 28,000 to 33,000 square miles.

Physically the country is dominated by a backbone range of mountains, the continental divide, consisting largely of igneous rocks and including a number of now extinct volcanos. This range is highest in western Panama; elevations of over 11,000 feet are reached, the highest point being El Barú (Volcán Chiriquí), at 11,410 feet. Eastward, the divide drops to lower elevations; the low point of 316 feet is reached at the Canal Zone, whence the range continues at around 2500 feet to near the Colombian border, where elevations of over 5000 feet are reached. For the most part the continental divide is closer to the Caribbean coast than to the Pacific, with the result that most of the agriculturally developed land is on the Pacific side, as are all but one of the major rivers.

Geologically the underlying structure is complex, reflecting a history of repeated changes, although at the present time the land is comparatively stable, and no serious earthquakes have occurred in recent times. Sedimentary rocks of tertiary age alternate with igneous intrusions and flows of lava and beds of ash. There is much folding and faulting. The soils are in general rather acid clays of low fertility, although areas with comparatively good soils do exist, especially in Chiriquí Province and the lowlands of Darién and Bocas del Toro Provinces. There are no large bodies of fresh water except for the artificial Gatún and Madden Lakes in the Canal Zone. Except for the lower reaches of the Tuira in Darién Province, rivers are rapid and shallow and not navigable except by dugout canoe and similar craft. There are extensive freshwater and tidal coastal swamps

on both coasts, especially at the mouths of the numerous rivers. On the Pacific coast, notably within the Gulf of Panamá, the tidal range is great, reaching 18 feet or more, while on the Caribbean coast it is barely two feet. Much of the coast line is rocky and precipitous or fringed with mangrove swamp and mud flats, though sand beaches occur in favorable localities on both coasts.

Originally most of the country was covered with forest, except for some drier areas along the Pacific coast which appear to have been grassland since prehistoric times. Man's agricultural activities in the past few centuries have changed much of this, especially on the more densely populated Pacific coastal plain, so that forest in this area is reduced to scrub on steep hillsides and narrow gallery forest along streams. The predominant and somewhat primitive agricultural practice consists of cutting and burning forest in the dry season to plant a crop in the ashes. A new patch of forest is destroyed each year, so that virgin forest in all accessible areas is rapidly disappearing. Repeated burnings prevent reforestation. This results in increasing areas of grassland, unsuitable for further agricultural use and with very depauperate fauna.

Panama has a hot, tropical climate which is somewhat tempered by the proximity of the sea. Temperatures at sea level in the Canal Zone area seldom go below 70°F. or above 90°F. though extremes of about 60° and 96° are sometimes encountered. Information is scanty for many areas, but in general extremes are slightly greater on the drier Pacific coast than on the Caribbean, and lower temperatures prevail at higher elevations. The diurnal temperature range is not great, seldom more than 10°F. Hot nights are rare. The year is divided into two climatic seasons, wet and dry, which are much more pronounced on the Pacific side than on the Atlantic. The wet or rainy season, known locally as *invierno*, or winter, generally extends from about the middle of April to the middle of December, although it varies greatly in duration and intensity locally and from year to year. During the rainy season, rain is to be expected on any day, most often in the afternoon and generally in the form of heavy local thunderstorms. Occasionally there are widespread rains of long duration, especially from October to December. Rainfall may be exceedingly heavy, up to 2.48 inches in 5 minutes and over 10 inches in a single 24-hour period.

Annual average rainfall varies from year to year and place to place, but it is generally heaviest along the Caribbean coast on the mountain slopes and least along the Pacific coast west of the Canal Zone. As much as 247 inches in a single year have been recorded from Porto Bello on the Caribbean and as little as 25 inches at Naos Island at the Pacific entrance of the Canal. Greater rainfall probably occurs in some mountain areas. Relative humidity is generally high, seldom below 60 percent during the day and almost always above 90 percent at night. During the dry season, the local *verano* or summer, there may be no rain, at least on the Pacific side, for as much as four months, and seldom is more than an inch a month recorded for the months from January through March. The Caribbean slope and mountains usually receive occasional showers, and in the wetter areas there is no real dry season.

Winds are seldom strong, and windspeeds of over 30 m.p.h. are exceptional. Panama is outside the hurricane belt. During the rainy season light and variable winds from the south are common or on occasion there may be strong winds of short duration, accompanying thunderstorms. During the dry season, the North East tradewinds may blow fairly steadily from January through March.

Politically the country is divided into nine provinces and the Intendencia of San Blas. Of these, Bocas del Toro, Colón, and San Blas lie wholly on the Caribbean coast; Veraguas fronts on both coasts, and the remaining provinces are wholly on the Pacific side of the continental divide. The Canal Zone is a strip about 10 miles wide from coast to coast dividing Colón and Panamá provinces.

Detailed delineation of life zones in Panama has hardly begun. Goldman in his *Mammals of Panama* (1920) discusses the problem and gives a provisional map. Standley in his *Flora of the Panama Canal Zone* (1928) devotes several pages to general descriptions of the plant associations in the Canal Zone. Holdridge and Budowski in a recent report (1955) discuss life zones in more detail, giving a map showing four life zones: *Tropical*, up to 600 meters altitude on the Atlantic coast, to 700 meters on the Pacific; *Subtropical*, from 600 or 700 to 1500 meters; *Lower Montane*, up to 2600 meters and *Montane*, over 2600 meters. These zones are further divided into dry, wet, and transition divisions. In general, the Tropical zone comprises 76 percent of the republic, the Subtropical about 18 percent, the Lower Montane and Montane together about 5 percent, the last occurring only on the highest mountains in Chiriquí Province. The classification is based largely on considerations of temperature, precipitation and forest associations. The mountainous nature of much of the country results in limited areas of high rainfall with associated rain shadows. This, coupled with edaphic and underlying geological features of circumscribed extent, cause abrupt changes in the vegetation cover over relatively short distances and render general statements subject to numerous exceptions. Thus, relatively low hills within a few miles of each other may have quite different vegetation and associated faunas. The same mountain may be clothed in grass and xerophytic scrub on its leeward side and dense fog forest on the windward side with practically no zone of transition.

For present purposes, and until much more detailed information is available, the country may be divided into three zones: below 1000 feet; from 1000 to 5000 feet; and over 5000 feet. These correspond very roughly to the Tropical, Subtropical and combined Submontane and Montane zones of Holdridge and Budowski. The collections reported in this group of papers have come very largely from elevations below 5000 feet, with some representation from areas in Chiriquí Province from above 10,000 ft. The accompanying map indicates these three zones.

A few collecting localities that are representative of these zones are described below.

**Cerro Punta** (Chiriquí) is a small village located on the slopes of Volcán Barú at an elevation of about 6000 feet. Extensive collections of mammals and ectoparasites were made in this vicinity (Bambito, Finca Lara, Casa

Tilley, Finca Martinz) at elevations of from 4800 feet to over 8000 feet. Rainfall is moderately heavy, and the dry season is distinct though not intense. The heavy forest is representative of the humid upper Tropical Zone, with oaks and bamboo occurring at the higher levels. The area is rapidly being cleared for coffee and vegetable crops.

**Finca Lerida** (Chiriquí) is a coffee farm between Boquete and Cerro Punta on the slopes of Volcán Barú at an elevation of between 5000 and 6000 feet. An area of virgin forest near the farm was preserved until 1955, but most of the adjacent area is now used for coffee and vegetable crops and for pasture. The former owner and his wife, Mr. and Mrs. T. B. Monniche, were interested in natural history, collected birds, and were hosts to many visiting naturalists, a number of whom collected ectoparasites.

**Almirante** (Bocas del Toro) is the headquarters town for large banana and cacao plantations operated by the Chiriqui Land Company. Extensive collections were made from August 1951 through May 1953 at a camp established about 12 miles southwest of the town for the study of sylvan yellow fever. From 1959 to 1962, collections were made at several other localities within a few miles of the town. All collecting localities are below 500 feet, and most are lower. They include virgin forest as well as swamp forest, second growth, and land under cacao and banana cultivation. Precipitation is high throughout the area. There is no pronounced dry season and no month regularly has less than three inches of rainfall. The town is situated on the Chiriquí Lagoon. Isla Bastimentos and Cayo Agua (Water Key) are islands in the Lagoon.

**Río Changena**, lower camp (Bocas del Toro) was a temporary camp on an eastern tributary of the Río Changuinola, about 20 miles inland, at an elevation of 2400 feet. The area is one of heavy tropical forest with continuous high rainfall throughout the year. Collections were made during September 1961, within a radius of two miles of the camp, and up to elevations of 3000 feet. Rain fell on more than half the days during this time. The ground was continuously wet, in degrees ranging from moist to saturated.

**Río Changena**, upper camp, or **Rancho Mojica** (Bocas del Toro), a small coffee farm, is located about 10 miles from the continental divide on the Atlantic side, at an elevation of 4800 feet. The collecting area is a tropical rain forest surrounding a four or five acre plot, once cleared but now supporting some secondary growth. A stream runs near the lower fringe of the clearing. Collections were made along the stream and along a trail on a high ridge ranging in elevation from 5000 to 5650 feet. The climate during the collecting period seemed drier than that at the lower camp.

**Cerro Hoya** (Los Santos) is a mountain area behind Las Palmitas. The higher elevations are heavily forested and appear to have abundant rainfall. Mammal and ectoparasite collections were made here from 11 January 1962 to 2 March 1962 at elevations between about 1000 and 3000 feet.

**Las Palmitas** (Los Santos) is a small settlement at the foot of Cerro Hoya, near the Pacific coast. The area is relatively dry, with an intense dry season. The land has been long under cultivation and little of the original vegetation remains.

**Canal Zone.** Numerous collections, all at low elevations, have been made on both sides of the isthmus in the Zone. Because of restrictions on agricultural use of land within the Zone, there are many areas of nearly undisturbed forest. On the Caribbean coast, in the Camp Piña and Mohinga Swamp areas, there are patches of virgin rain forest. Barro Colorado Island and Madden Forest provide successively drier habitats. In general, the rainfall pattern in this area is modified by the low elevation. The Caribbean coast is somewhat drier than adjacent areas and the Pacific coast has a less intense dry season than areas farther west. Considerable trapping was done in and about townsites and military installations, in small patches of second growth forest, scrub and grassland. Many collections have come from animals found dead on highways and from bats taken in abandoned buildings, road culverts, and old mine tunnels.

**Cerro Pirre** or upper **Río Setegantí** (Darién) is the location of a temporary camp, used during January and February 1961. It was situated on the western edge of a sloping valley or plateau, between the Cerro Pirre range and Cerro Setetule, one mile south of the Río Setegantí and 26 air miles to the south of El Real. The elevation of this camp was about 1500 feet, in an area of tropical rain forest broken by occasional marshy meadows and fields of wild cane. Collections were made in the valley itself and along a long, narrow, gently sloping spur, perpendicular to the Cerro Pirre range, up to an elevation of 3500 feet. Except for occasional trails of rubber collectors leading toward the nearby Colombian border, there is no evidence of human habitation of this area since the nearby Cana mines were closed about 45 years ago.

Weather data for this area is fragmentary. Judging from the dearth of deciduous trees and the abundance of surface water noted during the dry season, this area is more like the modified rain forest of the Atlantic Coast than the tropical wet and dry or Savanna Forest of the Pacific slopes.

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